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PRELIMINARY AND INTERIM REPORT ON INVESTIGATIONS ON THE PRODUCTION OF ALCOHOL FROM NIPAH PALMS.

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In connection with the possibilities of the production of power or fuel alcohol from local raw products, attention has been confined during the year to investigations on the Nipah Palm (*Nipah fruticans*).

Existing areas.

The following information in respect of areas of indigenous Nipah Palm has been supplied by the Conservator of Forests F.M.S. and S.S.

Perak North. Province Wellesley and Penang.

District.	Forest Reserve Acres.	State Land Acres.	Alienated Land Acres.	Total Acres.
Penang ...	...	...	200	200
Province Wellesley	...	...	1,800(*c*)	1,800
Matang and Krian	100(*a*)	100(*a*)	2,300(*b*)	2,500
	100	100	4,300	4,800

(*a*) The Nipah in forest reserves and state land is estimated only and is in small scattered patches.

(*b*) The areas given for alienated land in Perak are those shown in the titles of owners. The actual nipah is considerably less and for practical purposes is estimated at not more than 1,500 acres.

(*c*) No figures supplied by District Officer, Butterworth; estimated at 400 acres.

Perak South.

Total area estimated at approximately 8,000 acres, of which 7,600 acres are in Perak and 400 acres in Selangor. Roughly 75 per cent of this is alienated and the balance is State land. The area in reserves is practically negligible.

Selangor (Coast District).

Klang District—

		Acres.
State Land on banks of rivers	...	5
Alienated Land	...	1,313
Forest Reserves — Jugra Block II	...	100
Forest Reserves — Jugra Block I	...	25
Forest Reserves — Teluk Gedang	...	5
Forest Reserves — Pulau Lumat	...	150
Total		1,598

Kuala Selangor District—

		Acres.
State Land on banks of rivers	...	10
Alienated Land	...	656
Forest Reserve (Banjar Block II)	...	2
Total		668

Kuala Langat District—

		Acres.
State Land on banks of rivers	...	3
Alienated land	...	625
Total		628

Grand Total (Selangor) 2894 Acres.

Negri Sembilan.

		Acres.
State Land Sungei Raya	...	5
Alienated Land P. Kempas	...	200
Sungei Menyala	...	50
„ Rembau	...	200
Forest Reserve (Linggi proposed reserve)	...	50
Total		505

Pahang.

	Acres.
Pahang West	Nil.
„ East	3,000 (estimated)

The area of nipah in reserved forest and on alienated land in Pahang East is practically negligible.

It is very difficult to estimate the area on state land. Certain parts of the banks of all the rivers carry Nipah. the streams in the southern part of the State being especially well supplied.

The area on the Anak Endau is rather large and is believed to contain as much nipah as the rest of the State.

There is a good deal on the Pontian. On the Rompin, the palm is found for a great distance up stream, but the strips are rather narrow.

As a rough estimate and with no pretensions to accuracy, the total area in Pahang East is about 3,000 acres.

MALACCA.

	Acres.
Crown Land (near Rembau)	30
Alienated Land (Central District)	100
Forest Reserves (Sungei Linggi proposed reserve) ...	20
Total ...	150

OBJECTS OF INVESTIGATIONS.

In order to carry out and supervise tapping experiments and at the same time to undertake laboratory investigations of the sap or saccharine juice obtained by tapping the fruiting stalk it was necessary to select an area within reasonable distance of the laboratories. A number of areas on the small islands off Port Swettenham and other areas between Klang and Kuala Selangor were visited and it was eventually decided to select an area at the 15th mile Klang—Kuala Selangor Road and also to continue tapping observations on certain palms at Jeram.

The principal objects in view are:—

(1) Determination of yields of sap and period of tapping.

(2) Investigation of the composition of the sap and the changes which the sap undergoes during and after collection.

(3) Methods of planting.

Observations in connection with yields are rendered difficult by the fact that (*a*) it has not been possible to keep the tapping experiments under the continuous supervision of a European Officer (*b*) the history, age and previous treatment of indigenous palms is unknown.

With the exception of a few palms at Jeram, no suitable areas could be found on which palms had not been cut previously for attap. This cutting of the fronds has almost certainly a marked effect on the yields of sap.

Observations in connection with the composition of the juice are rendered difficult by the rapid changes which occur even during collection, necessitating investigations of a laboratory character on the spot.

Situation of Experimental Areas.

During the year three areas have been under observation as follows :—

Area A. Situated on the east of the Klang—Kuala Selangor Road at the 19½th mile (near Jeram).

The palms on this area are privately owned by a Malay (Haji Osman) and have been planted regularly in drains and may be described as cultivated palms.

Area B. Situated on the west of the same road, close to the coast at the 20th mile. This appears to be a "self planted" area.

Area C. Situated on the west of the same road, and adjoining the road at the 15th mile.

Description of Areas.

Area A. The palms on this land are planted at regular intervals in drains in a mixed Kampong.

According to Malays, palms planted in drains are growing under optimum conditions, due to the constant supply of water, except in very dry weather.

The palms on this land are very healthy in appearance and well cared for by the Malay owner, who appears to have a considerable knowledge of methods of treatment of the palm and the methods of tapping.

The height of some of the palms is about 45 feet, but the age is uncertain. They are said to consist of two varieties or types—Nipah Gala and Nipah Padi, the principal botanical or anatomical differences between the two types being the variation of the angle at which the leaflets emerge from the main stem or midrib of the fronds.

Area B. The palms on this area are growing in more or less swampy land near the coast. They are generally stunted in growth and have been extensively cut for attaps.

The results obtained from tapping on this area are of little value from the point of view of yields. This may be attributed partly to the difficulty of access, in consequence of which the preliminary treatment (gonchang) of the fruiting stalk was not systematically carried out. In addition, personal feuds between local Malays prevented work being done by men who were most conversant with the methods of treatment of the palm.

Area C. This area may be divided into two portions (1) an area of comparatively high ground on which water is obtainable by the palms chiefly during the monthly high tides, when the land is under water. The palms on this area are stated to have been planted by a Chinese in 1916 for the purpose of cutting for attaps. (2) An area of indigenous palms, a few of which (about six) were growing in small drains.

It is of interest to note that the average yield of sap from the latter was about seven or eight times the amounts obtained from the palms on the higher ground, although the highest yields were small in comparison with those of palms on Area A.

This area has also been utilised for the experimental planting of seedling palms.

Tapping Experiments.

Tapping has been carried out by two local Malays (Haji Osman, the owner of Area A, and Haji Suleiman).

The tapping of the fruit stalks has been preceded by the preliminary treatment of the fruit stalks, known as the "Gonchang" process, which is the only process known by the local Malays.

Later in the year, attempts were made to tap the flowering stalk or spathe before it opens, a method stated to be practised in Sarawak, but the experiments were uniformly unsuccessful.

Since these latter experiments were initiated, information has been received from the Conservator of Forests, British North Borneo, who states that this method of tapping has been tried by his forest rangers with the result that *for a few days a good flow of juice was obtained after which the stalks dried up.*

He stated further that the best results were obtained when the fruit on the stalk was about half mature.

According to local knowledge and practice it appears that the process of "Gonchang" should be commenced when the fruit bunch or head has a diameter of 6-7 inches, the preliminary treatment of the stalk lasting from $1\frac{1}{2}$ to 3 months, according to the growth and character of the fruit.

The results are also stated to be modified by the treatment given to the epidermis of the stalk, which should be cut away in wet weather, and left on the stalk if the treatment is carried out during dry weather.

In order to endeavour to reduce the period of preliminary treatment which, according to local Malay knowledge, is essential and which appears to be confirmed by our tapping experiments, it has been arranged to carry out further tapping experiments of both the immature or flowering stalk and the more mature or fruiting stalk by

practising the preliminary treatment accorded to the flowering spathe of the coconut palm when tapping for toddy. This preliminary treatment requires a period of about two weeks.

If a more successful and shorter period of preliminary treatment can be discovered, it will be a great advance and of considerable importance from the point of view of saving of labour in the commercial tapping of the palm.

Summary of Experimental Yields.

A summary of experimental yields obtained is given in Tables I, II and III attached.

An interpretation of the variation of these yields is rendered difficult by the comparatively large number of unknown factors involved such as (*a*) the health of the palms and previous history (*b*) age of palms, (*c*) foliage (*d*) water supply (*e*) methods of treatment.

No yields of palms on Area B are given, since the figures are, in our opinion, valueless, owing to the lack of systematic preliminary treatment of the palms before tapping.

A correct interpretation of the yields on Area A is also difficult, in consequence of the illness of the owner during the tapping period and the subsequent resumption of tapping by a less experienced tapper.

The following observations are offered on the results obtained.

Area A.—The yield from palms Nos. 1, 2 and 3 on Area A may be regarded as very satisfactory. The tapping of these palms was carried out during the early part of 1922 under continuous supervision and all the palms had been "gonchanged" for periods of 2—3 months.

Palm No. 4 also received regular attention and yielded about ¼ gallon of sap per day. The yield of palm No. 5 was very low; this palm is stated to have fruited for the first time.

It is also believed that the character of the internodes of the fruiting stalk in respect of length, has a considerable influence on the yields. The yields drop considerably near the nodes.

Table IV attached showing yields of Palms No. 6 and 7 illustrates the drops in yield at the nodes and the subsequent increases.

Area B.—The yields on this area are all poor, which is attributed to inefficient preliminary treatment of the fruit stalks before tapping.

Area C.—Most of the palms on this area are poor in growth and have been cut previously for attap. Nearly all of them are also planted on comparatively high ground, and obtain sufficient moisture only during rainy weather and at high tides.

With the exception of Palms Nos. 19, 21, 22, 23, 29 and 30 the yields are almost negligible. The better yielding palms are still giving

a comparatively good flow of juice, compared with other palms on this area. In our opinion the better yields of the six palms mentioned above are due to the fact that they are growing in drains and consequently have a better water supply.

Summary of Observations on Yields.

The yields obtained from the palms on area A show that satisfactory yields (say ¼—⅓ gallon of juice per diem) can be obtained from good palms under proper conditions of treatment and tapping. The poorer yields obtained on other palms later in the year are attributed to inefficient treatment of the palms due to the illness of the owner and the fact that a less skilled operator had to be employed.

It is not possible at the present stage to give any definite opinion on the average yields which are likely to be obtained continuously on a large scale, since the yields obtained in these experiments are for the period December 1921—March 1922 on some palms and for October 1922—December 1922 on others.

In order to obtain a more accurate idea of the yields per acre per annum, further observations are necessary on the actual number of fruit stalks which reach maturity during a period of at least twelve months and also, if practicable, to tap and measure the yields of juice obtained from such fruit stalks.

The latter however is not so important, in our opinion, as the former. In this connection it may be stated that one clump of four derived from one seed had thirteen fruits at one period in different stages of maturity while three clumps were observed with ten stalks each and several others with seven stalks, although the average number at any given time appears to be from three to four stalks.

The tapping experiments show that yields of ¼ to ⅓ gallon per palm per diem can be obtained under good conditions and all enquiries addressed to local Malays have elicited the information that the palms will yield about two chupahs per day.

It should however be pointed out here, that it is highly probable that apart from variation in yields due to the method of treatment and tapping, there will be considerable variations in yields from individuals palms due to hereditary factors as in the case of other economic plants and that yields can probably be improved by methods of selection. In the commercial exploitation of this palm, there are at present a number of unknown factors, in connection with the cultivation and yields, which are present especially in all agricultural enterprises.

Chemical Investigations on Juice.

Chemical investigations on the changes which the juice undergoes during and after collection have been carried out during the year.

According to Gibbs, in the Philippines, by using clean glass vessels for collection of the sap, inversion of the cane sugar in the sap is completed and the alcholic fermentation has reached its maximum at the end of about 17 hours.

Our investigations however show that the conditions in Malaya which affect the inversion of the sugar and the fermentation to alcohol are different. These results are surprising in view of the more tropical conditions in Malaya compared with the Philippines.

In experimenting on the fresh juice it appeared desirable to carry out investigations, as far as possible, on the spot, in order to avoid changes in the juice during transit.

Experiment 1.—This experiment included observations on the changes in density of the fresh juice during a period of nearly forty eight hours (excluding a night interval for sleep.)

Full details of these observations are omitted from this report, but they show the following results :—

The original specific gravity of the juice (28 minutes after tapping) taken at 10 a.m., at 25 °C was 1.0588 (compared with water—1.000) which corresponds to a saccharose (cane sugar) content of 15.41 per cent. This figure was confirmed subsequently by means of a saccharimetric reading. The acidity of the liquid was nil. At 2 p.m. the density had increased to 1.0589 and at 2.30 p.m. fermentation was indicated by the evolution of bubbles of carbon dioxide ; at 3 p.m. the density had risen to 1.0590. These increases in density are probably due to the inversion of the saccharose which on inversion absorbs 5.25 per cent of water.

$$\underset{\text{Saccharose}}{C_{12}H_{22}O_{11}} + \underset{\text{Water}}{H_2O} = \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

. At 4 p.m. the acidity of the juice amounted to 0.165 per cent. calculated as acetic acid.

At 9.15 p.m. the temperature had dropped slightly, but the density had decreased to 1.0585 showing that fermentation of the sugars to alcohol was proceeding. The acidity (as acetic acid) had increased to 0.24 per cent. The density of the juice was taken at further intervals during the night and by 11.30 a.m. on the following morning had only dropped to 1.0440 which showed that, even after 24 hours, the juice still contained about 11 per cent. of sugar (saccharose or invert sugar or both) ; at 7.30 a.m. on the following day (i.e. 45 hours after tapping) the density had only dropped to 1.020, indicating the presence of about 6.5 per cent of sugar.

Owing to the divergence of these results from Gibbs' experiments in the Philippines, a further confirmatory experiment was carried out.

Experiment 2.—A quantity of juice was collected and aliquot portions taken at intervals during 24 hours at the same place at which Experiment No. 1 was carried out.

These portions were run into a known excess of 96 per cent alcohol to arrest fermentation.

It was found that the sample removed at the end of 24 hours still contained 9.3 per cent of saccharose.

This result is important and shews that the fermentation in Malaya is easier to control than in the Philippines, provided glazed collecting vessels are used.

It has not been possible so far to carry out similar experiments with juice collected in bamboo vessels, but this will be done later.

It may be noted here, that the control of fermentation necessary for the manufacture of alcohol, must not be confused with the control necessary if sugar is to be manufactured, since the latter is a much more difficult proposition.

Experiment 3.—In view of the importance of the amount and character of the mineral salts present in the juice, in connection with the manufacture of sugar, a qualitative and quantitative analysis of the mineral matter is being undertaken. In the course of the concentration of juice in order to obtain the ash, further confirmation of the slow fermentation of the sugar, mentioned above, was obtained.

It was considered desirable, in order to avoid the large amount of carbonaceous matter, which would be produced on evaporation and ignition of the more or less fresh juice, to estimate the ash on old fermented juice. A sample of juice at least one month old was however found to contain large quantities of sugar in addition to acetic acid and traces of ethyl acetate.

This is probably explained (a) by an equilibrium in the system—sugar—alcohol—ethyl acetate-acetic acid (b) by the formation of a scum on the surface of the liquid which excludes air and prevents further fermentation and (c) destruction of the organisms present when the products of fermentation attain a certain concentration.

Qualitative analysis of the juice has shown the presence of the following elements—calcium, iron (traces) aluminium, magnesium, sodium and potassium, phosphates, sulphates and silicates.

Experiment 4.—The variation of the sugar content of the juice was determined on different dates and from different palms.

The results, which are given below, were determined by estimations carried out on the fresh juice about an hour after collection.

Sugar Content of juices of three Palms (Nipah Padi)

On first day of flow.

(1) 14.0 per cent. (2) 14.6 per cent. (3) 14.75 per cent.

Other Nipah Padi palms gave the following results :—

No. (1) 17.7 per cent.	No. (6) 16.3 per cent.
„ (3) 17.2 „	„ (10) 16.3 „
„ (5) 17.1 „	„ (11) 13.3 „

Repeat tests carried out on consecutive days gave the following results:—

Palm No. 1	One day	17.7 per cent.	
„ „	Next day	19.7 „	
„ „ 10	One day	16.3 „	
„ „	Two days later	11.5 „	(after heavy rain)

The following results were obtained on the juice from three stalks on palm (A) on Area A.

	Stalk 1	Stalk 2	Stalk 3
Sugar per cent. ...	11.5 ...	14.6 ...	14.0
„ „ ...	12.1 ...	10.1 ...	10.1
„ „ ...	16.3 ...	13.8 ...	14.2
„ „ ...	12.8 ...	13.5 ...	14.0
„ „ ...	13.0 ...	12.5 ...	13.9

In the case of two other palms (B & C) on this area, single estimations gave sugar contents of 13.9 and 14.2 per cent respectively.

An average sugar content of 12.5 per cent may be taken as a sound estimate.

Further determinations were carried out later in the year on the juice from palms on Area A.

The method employed was as follows:—

Small graduated flasks containing known amounts of absolute alcohol were attached to the Nipah stalks, so that the juice dripped direct into the alcohol, whereby formentation and inversion of the sugar was arrested. The samples thus collected were examined in the saccharimeter.

The following are some results obtained.

Day	Palm No.	1	2	3	4
1	Sugar (Per cent.)	12.1	14.2	10.1	13,65
2	„ „	11.2	12.7	9.8	11.75
3	„ „	10.8	13.75	8.3	13.07

These figures show that the quality of the juice in respect of sugar content varies from palm to palm and from day to day.

Production of Alcohol and Sugar.

Alcohol.—As stated above, natural alcoholic fermentation is far from complete after 24 hours, if glazed collecting vessels are used. A certain amount of ethyl acetate will also be formed, but this will not materially affect the quality of the alcohol for power or fuel purposes.

It is not anticipated that the manufacture of alcohol from the juice will present any considerable difficulties.

Sugar.—The manufacture of sugar of high quality and colour from the juice of the Nipah palm does however present certain difficulties. It is not possible to carry out any satisfactory quantitative

work in the laboratory on the yield and production of a high grade sugar, owing to the difference between laboratory and large scale practice.

Determinations of the purity of the juice will however indicate closely the percentage of first grade sugar which should be obtainable. The most generally applicable method of preservation of juice during collection is by the addition of lime in order to maintain an alkaline reaction.

It has been found that about 30 grammes of lime per litre of juice are necessary to preserve it completely. This amount is comparatively large and must be eliminated after the juice reaches the factory. It has been found that this can be accomplished fairly easily by means of settling tanks or vessels, in which the lime and matter precipitated with the lime sinks to the bottom of the vessels. It may prove economical to reburn and recover the lime. After this preliminary settling there will however be still a large excess of lime in solution, beyond the amounts usually present in cane sugar practice.

This lime may be removed by (a) carbonation or (b) treatment with alum.

The following experiments is this connection have been carried out :—

(*a*) The juice was heated and carbon dioxide passed through the solution until the precipitation of calcium carbonate was complete. The calcium carbonate was allowed to settle and the clear, almost colourless, supernatant liquor was concentrated under reduced pressure.

The colour of the liquor darkened as the concentration increased and the characteristic odour due to the presence of certain organic nitrogenous constituents developed. No nitrogenous material appears to be removed from the liquor during concentration. Four crystallisations of the resulting sugar were necessary to remove the odour and even then it appeared again, after the sugar had been standing for several days. The elimination of these odoriferous constituents requires further consideration.

(*b*) Method (b) at first sight appears to have many advantages over method (a). The essential feature of this process is that excess of lime is precipitated by the alum as calcium sulphate, while aluminium is precipitated in the form of flocculent alumina and the precipitate "drags" down a large amount of the soluble nitrogenous substances and colouring matter present in the juice.

The precipitate produced is however very voluminous and does not settle readily, even after standing for several days. By centrifuging however the liquor

may be cleared completely in about half an hour and the clarified juice so obtained is practically colourless.

On concentration however, periodic precipitation of calcium sulphate etc. occurs, which renders the method not so simple in practice.

Summary of Results.

1. The production of alcohol from the juice of the Nipah Palm should present no considerable difficulties, although it remains to be considered whether natural fermentation alone or aided by the addition of yeast cultures to the collecting pots will be more economical or efficient than attempting to collect a sterile juice with subsequent controlled fermentation in a central factory. It is believed that the latter may present too many difficulties, although it may prove satisfactory to sterilize the partly fermented liquor on reaching the factory and to complete the fermentation under control.

2. The production of a high grade sugar will present greater difficulties, especially in connection with the collection of a juice in which the saccharose has not become inverted during collection.

Further investigations are required in connection with (a) the elimination of the organic nitrogenous substances present in the juice, which appear to remain persistently in the sugar, as judged by the odour, and also in connection with (b) the quantitative investigation of the ash or mineral matter, which will affect the yield of first quality or crystallizable sugar.

3. The yields of juice obtained by tapping a number of palms are at present too variable to form an accurate estimate of probable yields of juice per acre, although it is possible to obtain yields of ¼ to ⅓ gallon per palm per diem.

4. On the information at present available both in the Philippines and from the comparatively small number of experiments carried out locally, the cultivation of the palm must still be considered in the nature of an agricultural speculation of considerable promise.

Cultivation.

Owing to the fact that every area of Nipah Palm so far examined has been cut previously for attap and is of unknown age and history, it has been considered desirable to acquire two small areas for planting seeds, in order to make observations on the growth and to ascertain the age at which the plants mature, which is said to be in 3—4 years from planting of seed.

One area has been acquired at the 15th mile, Klang—Kuala Selangor Road where the soil is washed by tides and the drainage water is brackish and the other area about 2 miles from Telok Anson on the Bagan Datoh Road where the soil is not affected by salt water. The two areas have been selected in order to ascertain whether the palms thrive best on soil affected by salt or fresh water.

Planting Methods.

Theoretical considerations of yields have hitherto been based on a planting distance of 12 ft. × 12 ft. giving almost exactly 300 palms per acre.

This distance appears to be suitable from the point of view of growth, although not from the point of view of transport of juice.

For transporting large quantities of juice to a central factory, it is probable that mechanical transport of some kind will be essential or the construction of pipe lines or flumes connected with large collecting tanks in the fields.

If the latter are adopted, a planting distance of about 12 ft. × 12 ft. should prove satisfactory but to allow for transport a distance of 12 ft. × 16 ft. will be probably more satisfactory.

The seeds or seedlings are planted preferably in drains or more correctly in the sides of drains or in openings cut out from the sides of drains.

A satisfactory method is to dig drains about 2 feet deep by 2 feet wide (the depth should vary according to the water table).

Every twelve feet along the drains the width is extended to four feet.

It has been found also that the young palms require shading and, since land suitable for planting the palms is frequently covered with blukar, it is preferable to leave much of this growth on the land, until the palms are well established. At a later stage the blukar can be cut down. The palms will eventually shade the ground sufficiently to prevent growth of weeds to any extent.

The cost of preparing the land by the construction of drains as above can easily be ascertained and can, if desirable, be carried out on contract. The cost of planting the seeds is small and the cost of upkeep on land of suitable character should be comparatively small.

It is probable that it may be desirable on many areas to regulate the water supply by means of water gates etc.

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TABLE I. (AREA A.)

Palm.	Number of Stalks.	Per day Highest yield per stalk.	Per day Lowest yield per stalk.	Per day Mean yield per stalk.	Period.			Per day Highest yield per tree.	Per day Lowest yield per tree.	Per day Mean yield per tree.	Remarks.
					Stalk 1.	Stalk 2.	Stalk 3.				
		ccs.	ccs.	ccs.				ccs.	ccs.	ccs.	
1	3	2035	620	920	Dec. 8th 21 to June 22nd 22	Dec. 8th 21 to May 30th 22	Dec. 8th 21 to June 24th 21	5585	890	2460	This palm appears at first sight excellent. It will be noted however that the mean yield per stalk is not extraordinary.
2	1	1680	675	1400	Unknown	.....	.....	1680	675	1400	Records incomplete.
3	1	1655	560	1200	..	.....	.....	1665	560	1200	Records incomplete.
4	2	1367	10	515	Sep. 7th 22 to Dec. 22nd 22	Oct. 6th to Dec. 22nd	.....	1910	90	1030	.....
5	1	430	15	170	Nov. 8th to Dec. 8th	.....	.....	430	15	170	Bad stalk, broken.
6	1	1140	20	385	Sept. 30th to Dec. 22nd	.....	.....	1140	20	385	Stopped tapping.
7	2	750	5	186	Sept 27th to Dec 22nd	.....	.....	1060	5	372	Finished.
8	2	1080	5	400	Sept. 15th to Sep. 18th	Oct. 1st to Dec. 22nd	.....	1080	10	400	.....
9	2	1410	5	300	Sept. 30th to Dec. 22nd	Oct 15th to Nov. 11th	.....	1595	120	600	Mean yield per stalk reached on one stalk only. Stalk 1 only yielding 195 ccs.
10	1	395	10	144	Oct. 20th to Nov. 9th	.....	.....	395	10	144	Still flowing.
11	1	350	10	117	Oct. 4th to Nov 3rd	.....	.....	350	10	117	.....
12	1	50	5	28	Nov. 3rd to Nov. 9th	.....	.....	50	5	23	First year of tapping.

AREA (B)

Table II.

Palm.	Number of Stalks.	Highest yield.	Lowest yield.	Mean yield.	Time of flow in days.	
		ccs.	ccs.	ccs.		
1.	1	30	30	30	1	
2.	1	106	21	60	8	
3.	1	146	8	110	14	
4.	2	70	15	35	6	
5.	1	245	15	98	24	
6.	1	22	10	19	1	
7.	2	160	15	80	14	
8.	1	10	10	10	1	
9.	1	65	15	33	5	
10.	1	40	40	40	1	
11.	1	210	10	72	22	
12.	2	336	10	162	28	
13.	1	230	25	100	14	
14.	1	55	10	33	5	
15.	1	28	10	20	3	
16.	1	54	5	27	6	
17.	1	56	10	28	10	
18.	1	60	10	33	8	
19.	2	812	134	524	22	Still yielding
20.	1	62	32	48	5	
21.	1	880	120	327	34	Still yielding
22.	1	458	32	202	24	„
23.	1	390	25	250	34	„
24.	1	156	15	47	20	
25.	1	120	12	70	9	
26.	1	234	10	80	21	
27.	1	28	10	29	10	
28.						
29.	2	560	100	284	34	Still yielding
30.	2	700	260	485	27	„

TABLE III.

Second Summary of Area (A).

Palm.	Time of flow in days.	Juice in Gallons.
1.	201	111.3
2.	—?	* (1/3 gallon per day)
3.	—?	* (1/3 gallon per day)
4.	87	19.8
5.	30	1.1
6.	84	6.7
7.	87	7.0
8.	83	7.5
9.	84	11.2
10.	20	0.6
11.	30	0.8
12.	6	0.4

* Yields taken for about 2½ months; observations on total tapping period incomplete.

AREA (A).

TABLE IV.

Date.	Palm 6.	Palm 7.	Date.	Palm 6.	Palm 7.
	ccs.	ccs.		ccs.	ccs.
27- 9-22	-	600	30-10-22	20	520
28- 9-22	—	800	31-10-22	25	480
29- 9-22	—	1053	1-11-22	45	565
30- 9-22	291	814	2-11-22	50	10
1-10-22	487	872	3-11-22	40	320
2-10-22	603	931	4-11-22	15	270
3-10-22	800	929	5-11-22	65	300
4-10-22	851	845	6-11-22	60	260
5-10-22	892	887	7-11-22	5	80
6-10-22	748	813	8-11-22	15	210
7-10-22	695	1060	9-11-22	10	294
8-10-22	870	830	10-11-22	5	200
9-10-22	830	670	11-11-22	60	-
10-10-22	1050	830	12-11-22	385	110
11-10-22	870	755	13-11-22	360	340
12-10-22	1180	800	14-11-22	230	265
13-10-22	915	750	15-11-22	190	230
14-10-22	910	745	16-11-22	170	180
15-10-22	425	465	17-11-22	310	270
16-10-22	450	300	18-11-22	50	30
17-10-22	225	300	19-11-22	110	130
18-10-22	165	460	20-11-22	210	270
19-10-22	155	485	21-11-22	130	30
20-10-22	510	760	22-11-22	160	130
21-10-22	385	475	23-11-22	40	270
22-10-22	560	485	24-11-22	210	140
23-10-22	540	640	25-11-22	150	130
24-10-22	390	650	26-11-22	550	50
25-10-22	490	620	27-11-22	520	160
26-10-22	390	590	28-11-22	380	370
27-10-22	260	570	29-11-22	230	310
28-10-22	50	530	30-11-22	100	310
29-10-22	20	440	—	—	—

PRELIMINARY NOTE ON THE TWO COLOURED COCONUT LEAF BEETLE, (*Plesispa Reichei*, CHAP).

By G. H. Corbett.

THIS insect belongs to the sub-family *Hispinae* of the family *Chrysomelidae* and is an important pest of the coconut palm in Malaya.

Maulick in his Fauna of British India gives a list of the *Hispinae* known to attack cultivated crops and enumerates the following as injurious to the coconut palm.

Promecotheca cumingi, Baly. Philippine Islands. Young shoots of coconut.

Promecotheca reichei, Baly. Samoa. Coconut.

Promecotheca opacicollis, Gestro. New Hebrides. Coconut.

Promecotheca coeruleipennis, Blanch. Fiji. Coconut.

Promecotheca antiqua, Weise. New Guinea and Solomon Islands. Coconut.

Bronthispa froggatti, Sharp. Solomon Islands. Coconuts.

It was considered that the larvae of all *Hispinae* were leaf miners but further observations have shown that the larvae of *Bronthispa froggatti*, Sharp., *Plesispa reichei*, Chap. and *Plesispa nipa*, Maulick, live on the epidermis of the leaf.

Froggatt* writing of *Bronthispa froggatti*, states that "the larvae of the beetles of this genus are not leaf miners but feed with the adult beetles upon the epidermis of the opening leaf-buds protected in the half-folded fronds."

Plesispa reichei and *Plesispa nipa*, the latter was found on nipah and sago palms near Malacca in 1921, have habits similar to *Bronthispa froggatti*, and the observation made by Froggatt concerning the larvae of the genus *Bronthispa* not being leaf miners will probably be found to hold good for the habits of the larvae of the genus *Plesispa*.

Literature concerning *Plesispa reichei* in Malay is exceedingly meagre presumably due to this insect not being so widely distributed as at present.

The first probable reference is contained in the Report of the Director of Agriculture for 1912 under the heading of Pests of Coconuts.

1914—15. Froggatt, W.W., "Bulletin Entomological Research" V. page 151.

"A small beetle was received from Johore belonging to the *Hispinae*. It was found in abundance, on coconuts and planters should keep an eye for it, in case it comes into the Federated Malay States. It has been a serious pest in the Philippines and can be recognised by its very flat shape, its yellow head and thorax, and bluish black wing-cases."

This insect is now generally distributed throughout Malaya.

General Descriptions of the Stages.

(*1*) *Adult.*

The beetles vary from 5—7 mm. in length.

The colour of the head, frontal projection, and antennae is dark brown. The prothorax is yellowish brown, the wing covers are black, and the abdomen in the middle, dark and at the sides, dark yellow.

The size of the insect frequently gives an indication as to the sex but the following characters should be verified before determination is made.

In the female, the frontal projection is broad at base, pointed at the apex, and compressed laterally. In the male, the frontal projection is slightly longer than in the female, slightly concave at sides, and about as broad at apex as at base. In the male the last abdominal sternite is more emarginate than in the female.

(*2*) *Egg.*

The egg is reddish brown in colour, about 1.75 mm. in length and .75 mm. in breadth. It is oblong ovate in shape and its upper surface slightly convex. The upper surface is partly covered with pieces of a pale yellow substance resembling leaf tissue.

(*3*) *Larva.*

The larva is flat, slightly convex, and dirty white or yellowish in colour. Full grown it is about 8.5 mm. long and 3 mm. broad.

There are eleven pairs of lateral projections, two pairs from the mesothoracic segment, one pair from the metathoracic and from the next eight segments.

The anal segment terminates in two caliper like projections and has on the dorsal surface a pair of spiracles.

(*4*). *Pupa.*

The pupa is flat, about 8 mm. in length, and at first of a pale yellow colour later changing to a deeper yellow. A pair of lateral projections arises from each of the seven abdominal segments. The last larval skin remains attached to the last abdominal segment of the pupa.

The approaching emergence of the beetle is indicated by the darkish colour of the wings showing through the elytra.

Manner of Feeding and Nature of Injury.

This insect, both in the larval and adult stages, feeds upon the upper and lower surfaces of the coconut palm leaves.

The whole period of its attack is confined between the folds of the tender leaves whilst they are still partially folded up.

Neither the grubs nor the beetles move far from the feeding places. They feed in a straight line without interruption, but, having advanced a certain distance, frequently turn round and feed in the opposite direction on the surface of the leaf parallel to the former feeding mark. Later, these feeding lines mingle with each other so that the remaining tissue dries and rots. Finally, the leaf tears and the young plants take on a peculiar weather beaten appearance and their growth is seriously retarded. If the attack has been severe and of long duration the plants die.

Age of Trees Attacked.

This insect is essentially a pest of seedlings in the nurseries and young plants in the field up to two or three years of age. When seedlings a few weeks old are attacked, most damage is done, but, on older plants, unless the grubs and adults are in large numbers, the injury is not of such great importance on account of the more extensive leaf surface.

Owing to the difficulty attending their examination, it has not been definitely ascertained if *Plesispa reichei* is generally distributed on older trees. The characteristic appearance described above of the palm leaves from the ground is difficult to see, but occasionally leaflets of the central leaves adhering to each other have been observed and on their examination this insect has been found.

Plesispa reichei has been collected from trees of eight, ten, and thirteen and a half years of age, and from an old tree at least 50 ft. high. In all cases, however, the trees appeared to have suffered from some previous injury or were growing in unhealthy conditions.

Host Plants.

A large number of different palms—ornamental and jungle-has been examined but though other Hispid beetles have been obtained the only other plant on which *Plesispa reichei* has been found is *Ortheodoxa regia*.

Beetle.

Before the beetles emerge from the pupae the wing sheaths appear greyish in colour but on their emergence the elytra are creamy white. The deceptive colouration of the adult in the pupa is due to the wings

which are smoky showing through the transparent wing covers. The elytra soon require the characteristic shiny black colour.

The beetles can fly and have been frequently noticed on the wing. They endeavour to shun light and will crawl to any convenient dark place.

Large numbers of beetles have been collected from time to time from the field and examined in order to find out the number of females as compared with males. The number of females is slightly in excess of male beetles, for instance in the last consignment of beetles received from the West coast of Malaya there were 101 males and 126 females.

The time elapsing before the newly emerged female deposited her first egg varied from 28 to 58 days.

Females after the first act of copulation took from 7 to 10 days to produce eggs.

Out of a total of 313 eggs, 185 hatched on the seventh day, 110 on the eighth day, 17 on the ninth day, and 1 on the tenth day giving an average of 7.46 days for the incubation of the egg.

The maximun length of time found for the life of the female was 287 days and for the male 273.

Adults deprived of food died in from 3 to 5 days.

Observations on the deposition of eggs showed that on two hundred occasions females laid eggs at an interval of one day, on two hundred and twenty-two at an interval of two, ninety four at an interval of three, thirty-five at an interval of four, twenty-one at an interval of five, six at an interval of six, five at an interval of seven, four at an interval of eight, one at an interval of nine, two at an interval of ten, two at an interval of thirteen, two at an interval of eighteen, and one at an interval of twenty-one days. On five hundred and sixty four occasions one egg was deposited and on thirty-three two eggs.

The largest number of eggs laid by an individual female was 112 in 249 days.

Larva.

There is little change in the colour of the larva during its growth. After moulting its colour is creamy white with indications of black eyes and brownish mandibles. Later the characteristic yellowish colour is acquired.

The larva passes through four instars. The larval skin is, however, not discarded on pupation but remains attached to the anal segment.

Results obtained from the records on the Moults of thirty grubs of *Plesispa reichei*, show that the average duration of the instars in days of the first is 6.2, of the second 6.4, of the third 7.1, and of the fourth 13.4, making the total in days 33.1, for the larval stage.

Pupa.

The pupa is always situated with its ventral surface to the leaf. If turned on its dorsal surface it regains its former position.

The pupa is capable of movement. Out of one hundred and seventy-two pupae placed with their heads away from the light, 110 remained in that position. Of the sixty-two which moved, 18 rested at about right angles to the light and 16 turned to the light whilst 28 remained with their heads away from the light.

The pupal stage lasts from 6-11 days; out of 100 pupae, in 3 cases the pupal stage lasted six days, in 65 cases seven days, in 25 cases eight days, in 4 cases nine days, in 2 cases ten days, and in 1 case eleven days.

The Summary of the Life Cycle.

	Minimum number of days.	Maximum number of days.	Average. number of days.
Egg	7	10	7.46
Larva	30	38	33.10
Pupa	6	11	7.40
	43	59	47.96

Under natural conditions twenty newly hatched larvae placed on five seedling palms reached the adult stage in the following number of days 38, 43, 41, 38, 37, 40, 40, 38, 36, 37, 38, 41, 42, 38, 37, 39, 41, 40, 43, 47, these figures give an average of 39.7 days which is similar to the average number of days (40.5) for the larva to reach adult condition in the above "Summary of the Life Cycle."

A Chalcid egg parasite has been recently found and preliminary observations indicate the eggs of *Plesispa reichei* are not highly parasitised and breeding work shows that the time elapsing between the parasite laying an egg in the egg of *Plesispa reichei* and emergence of the adult may be 8 days.

Preventive and Remedial Measures.

Plesispa reichei is essentially a pest of seedlings in the nursery and young palms in the field, and if the palms are growing under healthy conditions, little permanent injury is caused owing to the plant continually increasing its leaf surface.

In nurseries planted under coconut palms, grubs and adults are usually found retarding the growth of the seedlings, and it is particularly important that nurseries should be made either in an empty space with shade or under trees other than coconuts.

On an Estate where *Plesispa reichei* was present in large numbers, seedlings of two months planted under coconut trees showed the presence of beetles whilst under rubber trees not far removed seedlings of six months were free from beetles.

In planting or supplying seedlings from the nurseries to the field, the young palms should be freed from the presence of eggs, larvae, pupae, and adults of *Plesispa reichei* by collecting or immersing the whole seedlings in Lead Arsenate at the rate of 4 lbs. to 100 gallons of water.

This Lead Arsenate solution is readily made. The amount of the Lead Arsenate is made up at first into a thin paste in a suitable vessel and then diluted with the requisite quantity of water.

Immersion will wash off a number of the different stages of *Plesispa reichei* and the poison on the plant will kill the remainder. If the plants have been subjected to heavy rain after the first immersion, it may be necessary to immerse them again before planting out or if planted out, to spray them so as to kill the young larvae which have hatched from eggs since the first immersion.

When the insects are present on young palms in the field an application of the solution of Lead Arsenate by spraying well into the centre of the palms once every three weeks will probably be found cheaper and more effective than hand collection.

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THE COMPOSITION OF KEDAH AND PERLIS PHOSPHATES.

By V. R. Greenstreet.

DURING the last two years a number of samples of Kedah and Perlis phosphates have been analysed with a view to determining their value as fertilisers,

Description of Samples:—All the samples were decidedly heterogeneous and their colour ranged from light brown to chocolate. They contained many large particles and the samples for analysis were all well mixed and powdered.

The following table gives the results of the analyses:

Numbers 1, 2, and 3 were from Gunong Keriang, Kedah.

„ 4, 5, and 6 were from Bukit Keplu, Kedah.

„ 7 and 8 were Perlis.

„ 9 and 10 were purchased in Penang and were probably Perlis phosphates.

		1	2	3	4	5	6	7	8	9	10
Moisture	%	3.1	2.6	9.0	3.4	2.3	3.8	.51	—	—	4.6
Loss on ignition	,,	13.8	16.3	10.9	9.3	7.9	11.6	17.6	—	11.7	—
Acid Insoluble	,,	20.0	16.8	26.0	43.8	47.0	51.0	17.8	12.0	40.5	—
Phosphoric Acid (P_2O_5)	,,	21.4	31.4	16.7	18.5	20.5	11.5	10,8	18.7	12.0	6.8
Total Nitrogen	,,	0.32	0.67	1.5	0.36	0.55	0.74	0.34	traces	0.16	0.50
Albuminoid Nitrogen	,,	0.23	0.60	1.12	0.24	0.44	0.63	—	nil	—	—
Ferric Oxide & Alumina ($Fe_2O_3 + Al_2O_3$)	,,	32.0	32.6	33.6	22.8	21.6	19.5	9.6	43.3	26.5	—
Lime (CaO)	,,	9.7	0.26	3.85	2.18	0.70	2.60	25.6	traces	nil	nil

Remarks and Conclusions:—Sample No. 7 was particularly heterogeneous. It contained two definite constituents (a) pale yellow crystals (b) chocolate coloured and amorphous. Upon ignition the crystalline constituent became pure white. It was found to consist chiefly of calcium hydroxide with a small proportion of calcium phosphate. After exposure to the atmosphere for a few months it combined with carbon dioxide from the air to form calcium carbonate. The amorphous constituent upon ignition became pale pink. It contained all the nitrogen and no calcium: the aluminium and a little iron was found to be combined with the phosphoric acid. The "available" phosphoric acid (soluble in 1 per cent citric acid) amounted to 5 per cent on the mixed sample. This "availability" may be attributed to the mass action of the large excess of soluble calcium hydroxide over the proportion of aluminium and iron.

The other samples of Perlis phosphate contained no calcium and although two of them contained a higher percentage phosphoric acid than No. 7 this was combined with aluminium and iron in a form which is considered to be unavailable.

The Kedah phosphates contained more phosphoric acid than the Perlis phosphates but in every case the aluminium and iron were so largely in excess of the lime that the mass effect of the latter in rendering the phosphoric acid "available', would be negligible.

As nitrogen fertilisers these phosphates have a small value and in this respect the Kedah phosphates show superiority.

Pot-culture experiments with one sample of Perlis phosphate (Sample No. 7) have shown it to be inferior to Christmas Island phosphate in which the phosphoric acid is exclusively combined with lime. Large scale fertiliser experiments on padi are in progress.

Summary :—Kedah and Perlis phosphates show great variation even amongst themselves and are very heterogeneous products. The phosphoric acid in Kedah phosphate varies from 12 per cent to 31 per cent and in Perlis phosphate from 7 per cent to 19 per cent. It exists in combination with aluminium and iron largely in the form of of Wavellite (hydrated aluminium phosphate). One sample of Perlis phosphate examined contained a large excess of lime which rendered the phosphoric acid "available." In every other sample the aluminium and iron predominated.